EFFECTS OF HAMSTRING ECCENTRIC EXERCISES TO IMPROVE A PERFORMANCE IN SEMI-PROFESSIONAL FOOTBALL PLAYERS: AN EXPERIMENTAL STUDY

Dissertation submitted to

The Tamil Nadu Dr. M.G.R. Medical University

Chennai

In partial fulfillment of the requirements for the degree of

MASTER OF PHYSIOTHERAPY

(SPORTS)

Reg. No. 271750231

MAY – 2019

COLLEGE OF PHYSIOTHERAPY
SRI RAMAKRISHNA INSTITUTE OF PARAMEDICAL SCIENCES
COIMBATORE – 641044

CERTIFICATE

This is to certify that the dissertation work entitled **"Effects of Hamstring Eccentric Exercises to Improve a Performance in Semi-Professional Football Players: An Experimental Study"** was carried out by the candidate bearing the **Register No. 271750231 (MAY 2019)** in College of Physiotherapy, SRIPMS, Coimbatore, affiliated to the Tamil Nadu Dr. M.G.R Medical University, Chennai towards partial fulfillment of the **Master of Physiotherapy (Sports).**

Prof. B. SANKAR MANI, MPT (Sports)., MBA,
Principal,
College of Physiotherapy,
SRIPMS,
Coimbatore – 641044.

Place: Coimbatore

Date:

CERTIFICATE

This is to certify that the dissertation work entitled **"Effects of Hamstring Eccentric Exercises to Improve a Performance in Semi-Professional Football Players: An Experimental Study"** was carried out by the candidate bearing the **Register No.271750231 (MAY 2019)** in College of Physiotherapy, SRIPMS, Coimbatore, affiliated to the Tamil Nadu Dr. M.G.R Medical University, Chennai towards partial fulfillment of the **Master of Physiotherapy (Sports)** under my direct supervision and guidance.

Prof. B. SANKAR MANI, MPT (Sports)., MBA,
Guide,
College of physiotherapy,
SRIPMS,
Coimbatore – 641044.

Place: Coimbatore

Date:

CERTIFICATE

This is to certify that the dissertation work entitled "**Effects of Hamstring Eccentric Exercises to Improve a Performance in Semi-Professional Football Players: An Experimental Study"** was carried out by the candidate bearing the **Register No.271750231 (MAY 2019)** in College of Physiotherapy, SRIPMS, Coimbatore, affiliated to the Tamil Nadu Dr. M.G.R Medical University, Chennai towards partial fulfillment of the **Master of Physiotherapy (Sports)** was evaluated.

INTERNAL EXAMINER **EXTERNAL EXAMINER**

Place:

Date:

ACKNOWLEDGEMENTS

First and foremost, I pay my homage and bow before the **Almighty God** for his divine blessing and never failing guidance and mercy that I had experienced through every step of my project and its successful completion.

I am indebted to my father **R.GUNASEKAR**, my mother

G. AZAGARASI, my brother **G.POOVARASAN,** **B.E (Civil),** and my sister **G.DIVYA,** **Bsc (Maths),** for their love, support and encouragement throughout this endeavour.

My sincere gratitude to **Prof. B. SANKARMANI,** **MPT., MBA.,** Principal and my project guide, College of Physiotherapy, SRIPMS, Coimbatore, who shared the vision and work involved in this research and also for his valuable time and expertise, and for motivating me towards the successful completion of this study

It is privilege to express my sincere gratitude to Prof. **V.S.SEETHARAMAN,** **MPT (ORTHO),** Vice-Principal and clinical co-ordinator College of Physiotherapy, SRIPMS, Coimbatore for his kind help and support and valuable suggestions throughout the academics.

I would like to extend my sincere thanks to **Asst.Prof. AHAMED THAJUDEEN,** **MPT (SPORTS)** and to all my **PROFESSORS** for their constant guidance and valuable advice throughout the academics.

My special thanks to **Mr. S.DHAMODHARASAMY,** **MA.Business Economics,** **Mr. GURU**, team coach and **V.TAMIL ARASAN, B.com,** physical education trainer (P.E.T), thadagam for the kind help and support.

I extend my thoughtful thanks to my **FRIENDS** who were with through this study, for their moral support and encouragement.

I also express my sincere gratitude to all **PLAYERS** for their kind cooperation in making this study possible.

My thanks to all the other individuals who were individually responsible for helping me to complete my project work.

TABLE OF CONTENTS

Chapter No	Contents	Page No
1	**Introduction**	**1-6**
1.1	Aim	5
1.2	Objective of the Study	5
1.3	Need for the Study	6
1.4	Hypothesis	6
2	**Review of Literature**	**7-10**
3	**Methodology**	**11-15**
3.1	Study Design	11
3.2	Study Sampling	11
3.3	Sample Size	11
3.4	Study Setting	11
3.5	Study Duration	11
3.6	Treatment duration	11
3.7	Selection criteria	11
3.8	Materials	12
3.9	Treatment Techniques	12
3.10	Tools used in Study	15
3.11	Outcome Measures	15
4	**Data Analysis and Results**	**16-22**
5.	**Discussion**	**23-25**
6.	**Conclusion**	**26**
6.1	**Limitation**	27
6.2	**Recommendations**	27
	References	28
	Bibliography	33
	Appendices	34-43
	Appendix I	34-35
	Appendix II	36-42
	Appendix III	43

LIST OF TABLES

Table. No	CONTENTS	Page. No
1.	Triple hop distance test Control group:	17
2.	Triple hop distance test Experimental group	18
3.	Triple hop distance test control group and experimental group	19
4.	Repeated sprint ability test Control group	20
5.	Repeated sprint ability test Experimental group	21
6.	Repeated sprint ability test Control group and Experimental group	22

LIST OF GRAPHS

Graph. No	Contents	Page. No
1.	Triple hop distance test Control group:	17
2.	Triple hop distance test Experimental group	18
3.	Triple hop distance test control group and experimental group	19
4.	Repeated sprint ability test Control group	20
5.	Repeated sprint ability test Experimental group	21
6.	Repeated sprint ability test Control group and Experimental group	22

1.INTRODUCTION

Foot ball is the most popular sport around the world there are 207 associations, with almost 38 million foot ball players, in the International Federation of Football Association (FIFA) and almost 250 million people play it today[1].

Foot-ball players have been increased between 2008 to 2017 from 21.9 to 26million[1-3]. The number of football players has increased dramatically, until the next year there will be the semi-professional football league. As a result, the number of injuries should be proportionally increased[3].

It has been well documented as lack of hamstring strength its end up to reduction in performance of sprinting and kicking force, risk of hamstring tendinopathy and having four to six times greater risk of injuredto an athlete[4-5].

The need for primary prevention and improving a performance by implementing ofNORDIC HAMSTRING STRENGTHENING to a semi-professional football player to find out a effectiveness of this training in Sir Ramakrishna College football players.

It has been hypothesized that hamstring injuries are likely to result from eccentric overload during the terminal swing phase of high velocity running gait (Garrettet al. 1987)[6]. The analyses during sprinting have shown that muscle activity is highest during the late swing phase, when the hamstring muscles work eccentrically to decelerate the forward movement of the leg, as well as during foot-strike, in the transition from eccentric to concentric muscle action (Mann, 1981; Jonhagen et al., 1996)[6-9].

The authors showed that the peak hamstring torque occurred at a significantly shorter muscle length in the previously injured hamstring when compared to controls, indicating what may be termed a shift in the length-tension curve[8-10].

It is possible that when an athlete sustains a hamstring strain they potentially return to play with weakness at longer muscle lengths possibly predisposing them for a hamstring strain during the eccentric terminal sprinting movement during play[9].

It has been well established in the literature that eccentric training is effective in the prevention of hamstring strains[10].

The authors feel that the eccentric training should be done not just in the seated position from 90 degrees to full knee extension, but should include training in the lengthened state[10]. We hypothesize that training in the lengthened state may help lift the curve to acquire the necessary eccentric strength at the end of the range of motion to avoid susceptibility to further injury[11].

The absence of rehabilitation focusing on lengthened state eccentric training may explain the disproportionally high rate of recurrence[11]. Therefore, it is the belief of the authors that complete rehabilitation of a strained hamstring should include lengthened state eccentric training in order to minimize exposure to further muscle strain[11-12].

Unfortunately, despite the best prevention programs hamstring strain injuries still occur[12]. In most of hamstring rehabilitation program clinicians are implementing a Nordic hamstring exercise to rehabilitate an athlete and concentrating to improve muscle strength, lengthening, performance of the muscle[13].

Isolated findings of physical assessments may be frequently poorly related to functional impairments. Otherwise, biomechanical evaluations of athletic performance and clinical conditions can be performed using functional exercises[14]. Single leg triple hop test (SLTHT) may provide more relevant information on knee stabilizer muscles than isolated isometrics or iso-kinetic torque analysis[15].

The several muscles have such changes, including the gluteus medius, hamstrings and the different portions of the quadriceps femoris, gasterosoleus muscles general, the first half of the movement was characterized by ankle, knee and hip flexions with an eccentric contraction of the extensor muscles, slowly lowering the center of mass[16-17].

This pattern was remarkable in hip extensor, biceps femoris, semimembranosis, semitendinosis and gluteus maximus the psoas major increased anterior pelvic tilt and hip flexion, while gluteus medius and minimus stabilized the pelvis in the frontal plane[18]. Knee extensors and ankle plantar flexors werealso active during this phase[18-19].

The ability to produce a high rate of power output and to sprint a high velocity is essential toperformance in team invasion games. Furthermore sprinting in football fluctuates in its intensity scholasticmanner so players required to sprint repeatedly in any direction, players should refer ability to regularly reproduce a maximal sprint support during play C.B WARRG et, al. has highly recommended repeated sprint ability test to identify a acceleration speed of an player[19-23].

Single leg triple hop test (SLTHT) may provide more relevant information on knee stabilizer muscles than isolated isometrics or isokinetic torque analysis Estimations of muscle force in high demand tests have the potential to predict functional performance and define treatment planning[24-27].

Musculoskeletal models allow estimating muscle synergies regarding forces and activations during a functional task[27].

The main novelty presented by this paper was the estimation of lower limb muscles activation and force during the preparation phase of SLTHT in a group of healthy young women[28].

During the SLTHT preparation phase, the volunteer slightly lowers her body center of mass and then changes the movement direction, producing a high hip abduction and hip extension and knee extension torques to perform the first jump[29-30].

THD is a strong predictor of lower limb muscular strength and power in a healthy soccer population and support its clinical usefulness as a preseason screening test in a coeducational NCAA Division I soccer population.

Those assessments allow adequate prescription and monitor improvements caused by physical training aiming high-performance attainment. Accordingly, there is a necessity for development and use of assessment protocols to identify these improvements respecting specific metabolic ways for energy contribution worn in each of the sport. Currently, more attention has been devoted to anaerobic capacity or power to attain optimum performance, as well as the presence of repeated sprint ability.

The ability to perform sport activities under fatigueconditions is of great importance, 10 as injuries often occurtoward the end of a sporting event when a participant isfatigued. Therefore, to better evaluate the effectiveness oftraining or rehabilitation interventions, testing under fatigue conditions should be encouraged. A major fitness component for successful participation in team sports is RSA, that is, the ability to recover and to maintain maximal power/speedover a series of high-intensity sprints, coping with repeated about of high-intensity exercise and effort. The RSA test wasvalidated in team sports with different distances and numberof sprints including basketball, soccer, and handball.

1.2 AIM

To find out whether the effectiveness of General warm-up training and Nordic hamstring eccentric training will improve a performance in semi-professional football players.

1.3 OBJECTIVE OF THE STUDY

To find out whether the effectiveness of General Warm-up training will improve a performance in semi-professional football player.

To find out whether the effectiveness of Nordic hamstring eccentric training will improve a performance in semi-professional football player.

1.3 NEED FOR STUDY

1. Hamstring muscle strain is not only result in numerous visits to emergency care facilities and significant time loss from sports participation but they can also cause long term disability.
2. Among 2.18million players 15 %(1million) of athletes sustain in hamstring injury due to the sudden twisting and cutting movements involved in sport.
3. There are lot of conventional training methods are followed in all sports clubs and clinical settings according to the coach and the trainer way of training, but the complete proper training is not followed.
4. Without adequate care of proper training or strengthening can lead to reduced in sprinting performance and also leads to hamstring injury. (Br J sports Med 2006; 40:610-613.)

1.4 HYPOTHESIS

Null hypothesis:

There is no significant difference between the effects of hamstring eccentric exercise to improve performances in semi-professional football players.

Alternative hypothesis:

There is significant difference between the effects of hamstring eccentric exercise to improve performance in semi-professional football players.

2. REVIEW OF LITERATURE

Christian Sebelienet al. (2014) authors are purposed of this study was to investigate the effect of an NH exercise program combined with traditional training, versus traditional training alone, on hamstring and quadriceps strength, sprinting speed a number of hamstring injuries in semi-professional soccer player. Our hypothesis was that the player, who participated in the NH exercise in addition to their usual training program, would experience a decreased number of hamstring injuries, improved sprinting speed and increased hamstring and quadriceps strength compared to the control group who participated in a traditional training program.

Jesper Petersen et al. (2011) It is possible to reduce the incidence of hamstring injuries in professional and amateur soccer significantly by completing a training program that focuses on increasing eccentric hamstring muscle strength. The training program is able to reduce the injury rate of new injuries by more than 60% and an important clinical finding of this trial is that the interventional is highly effective in reducing the rate of recurrent injuries when completing the training program was documented.

B.J. Gabbe et al. (2006) The prevention of hamstring injuries in Australian football simple pre-season program might reduce the incidence of hamstring injuries. The intervention selected for investigation was a simple and inexpensive eccentric exercise program shown to produce a potentially protective change in muscle function.

Ross Clark et al. (2005) The purpose of this pilot study was to assess the effect of predominantly eccentric hamstring training programme on iso-kinetic variables associated with hamstring injuries and lower body dynamic power. The pre-intervention result for position of peak hamstring torque for the untrained subject participating in this experiment were similar to these found in uninjured elite athletes in a previous study (Brockett et al., 2004). The subjects in the present study recorded slightly higher pre-training knee extension angles for production of peak torque in comparison to elite athletes in the previous study for both right (14.9%) and left (5.9%) hamstrings.

A.Arnason et al (2007) The study was that eccentric strength training with Nordic hamstring lower combined with warm-up stretching seems to be effective in preventing hamstring strain in soccer. In contrast stretching during warm- up and flexibility training of the hamstring group had no effect on the incidence of the incidence of strains.

Roald Mjolsneset al (2003) The eccentric strength exercise NH was more effective than a concentric strength exercise HC in developing maximal eccentric hamstring strength measured at 60 s among well-trained male soccer player. No change was observed in maximal concentric quadriceps torque in any of the group. Consequently, there was a significant increase in H:Q ratio in the NH group, but not in the HC group. Significant gains were also seen for maximal isometric torque in the NH group at the three-knee angle tested while no change was observed in the HC group.

Matt Brughelli (2009) Study on the effects of eccentric exercise on optimum length in an athletic population. The results of the study suggest that eccentric based training can shift the optimum length of two opposing muscle groups i.e. the knee flexors and knee extensors. (Brooks et al.,2006; Proske et al., 2004) The main finding of the present study was that a group of professional male soccer players performing extra preseason eccentric exercise significantly increased their optimum lengths during knee flexion and extension in comparison to a CG.

Johnny Padulo et al (2016) This study assessed the sensitivity, reliability, and validity of RSA for confirming the functional recovery status in injured soccer players (CH), by comparing their neuro- muscular responses under a fatigue condition with a matched sample of healthy subjects (GH). Repeated sprint ability is a validated exercise/test for evaluating the ability to perform sport activities under fatigue conditions in team sports.

Wladimir Rafael Beck et al (2014) RAST is the only procedure that aimed to estimate anaerobic power. MART and W are good predictors of anaerobic capacity and ability, respectively, and the performance assesses seem to be more related to anaerobic power. So, P50 could be applied in daily training to estimate the anaerobic power a simple, fast and reliable way.

R. Tyler Hamilton et al (2008) The primary finding of this study was that THD was a strong positive predictor of performance on clinical power and strength tests. This result suggests that THD is a valid test of lower limb power and strength in National Collegiate Athletic Association Division I soccer players. However, we found

no relationship between THD and balance as measured by the BESS. The following discussion addresses the relationships noted between THD and each of the dependent measures.

K. Kormmeset al (2017) The study on effect of Performing the full 10-week Nordic Hamstring Protocol during preseason in elite soccer players did not seem to negatively affect sprint and vertical jump performance outcomes, while in fact showing some promise for the more explosive characteristics such as the short 5 and 10 m split-times and maximal countermovement jump height compared to control group or baseline measures. The data from the present study are in line with previous findings of both maintained or increased sprint and jump performance when performing the Nordic Hamstring exercise with smaller dosage or as part of additional strength training. Previous studies on sprint performance in elite male football players have demonstrated a difference in maximum mean 10 m sprint times between the top and bottom 25th percentile of 0.08 s, suggesting the median improvement of 0.078 s (mean 0.14 s) observed in the intervention group could be clinically relevant if replicated in adequately powered future trials.

3. METHODOLOGY

METHODOLOGY

3.1 STUDY DESIGN

The study design isExperimental study

3.2 STUDY SAMPLING

Convenient sampling technique

3.3 SAMPLING SIZE

20 subjects were assigned into two group.10 subjects in the control group and 10 subjects in experimental group.

3.4 STUDY SETTING

This study was conducted at Sri Ramakrishna College Ground.

3.5 STUDY DURATION

The study was carried out by a period of 12 months.

3.6 TREATMENT DURATION

The training was given for 3 sessions in a week for period of 5 weeks.

3.7 SELECTION CRITERIA:

Inclusion criteria:

- Age between 18 to 30 year
- Gender-Male
- Semi -professional football players

Exclusion criteria:

- Lower extremity injuries
- Back pain
- Recent Surgeries
- Current hamstring injuries
- Upper extremity injuries

3.8 MATERIALS

- Stop watch
- Measuring Tape
- Traffic Cone
- Stationery's
- Recording sheet

3.9 TREATMENT TECHNIQUES

A total of 20 semi-professional football players selected as a sample. Using convenient sampling technique 20 subjects were assigned into the **Control Group & Experimental Group**.

Control group:

The subject in this group received General warm-up exercises.

Experimental group:

The in subject this group received General warm-up exercises and Nordic hamstring exercises.

PROCEDURE

After obtaining informed consent from all participants by using convenient sampling method for 20 participants they will be allocated into two groups as **Control group** and **Experimental**

group. Control group received General warm-up exercises. Experimental group received General warm-up and Nordic hamstring exercises.

TESTING PROCDURE

Before and after an intervention for both groups are pre-test and post test procedures consisted of (1) **TRIPLE HOP DISTANCE TEST**, (2) **REPEATED SPRINT ABILITY TEST**

THDT and RSAT for escalation performance.

Control group:

Consisting of jogging progressing to light sprinting was performed for 10 min. in a standing position, the participants were asked to alternately kick their right and left heel as close to their buttocks as possible in 3 sets of 20 repetitions(figure1). Then 3 sets of 10 repetitions of lifting their knees as close to their chest as possible(figure2). Self stretch of hamstring (20 sec) (figure3) and partner stretching for (45sec) players should have to perform it (figure 4).

Experimental group:

Consisting of jogging progressing to light sprinting for (10 min), Butt kick for 3 set 20 repetitions, knee to chest for 3 sets 10 repetitions, self stretch (20 sec) and partner stretching (45sec). Followed by Nordic hamstring exercise (figure5) also performed with a partner to avoid cramps try to relax the ankles and calves during the exercises. Sets and number of repetition were gradually increased through the fourth week.

Nordic Hamstring Strengthening Protocol

Weeks	Session	Sets	Repetitions	Comments
1	1	2	5	Straight upper body (with a slight bend in the hip) Throughout the whole movement. Resist falling as long as possible. Fall on your arms, let the chest touch the surface and Push up immediately, until your hamstring muscles can take over the movement.
2	2	2	6	Try to reduce the lowering speed more.
3	3	3	6-8	Gradually increased load. You can resist falling even longer and for an increasing number of repetitions.
4	3	3	8-12	Full program: 12, 10and 8 repetitions.
5	3	3	8-12	When you can control the movement in all repetitions.

3.10 TOOLS USED IN THE STUDY

1. Triple hop distance test
2. Repeated sprint ability test

3.11 OUTCOME MEASURE

1. Muscular strength
2. Sprinting speed

4. DATA ANALYSIS AND RESULTS

Data collected from participants of the same group (intra group) were analyzed using paired' test and the difference between the two groups (inter group) were analyzed using independent 't' test. Differences were considered at significant level of 0.05%.

Independent't' test:

The "t" value was calculated using the formula,

$$\mathbf{t} = \frac{\bar{x}_1 - \bar{x}_2}{s}\sqrt{\frac{n_1 n_1}{n_1 + n_1}}$$

$$\mathbf{S} = \sqrt{\frac{\sum(x_1 - x_1^1)^2 + \sum(x_2 - x_2^1)^2}{n_1 + n_2 - 2}}$$

$$\boldsymbol{\delta} = \sqrt{\frac{\Sigma d^2 - n(\sum d)^2}{n-1}}$$

Paired' test:

The "t" value was calculated using the formula,

$$\text{'t'} = \frac{(\sum D)/N}{\sqrt{\frac{\sum D^2 - \frac{\sum D^2}{N}}{(N-1)(N)}}}$$

Table: 1 Triple hop distance test Control group:

Outcome measure	Test	Mean	Standard deviation	Calculates 't' value	P value
THDT (RT)	PRE TEST	4.3240	0.4457	5.0377	0.0007
	POST TEST	4.4130	0.4303		
THDT (LT)	PRE TEST	4.0780	0.4058	8.9642	0.0001
	POST TEST	4.1280	0.0350		

There was a significant difference in the outcome measure of Triple hop distance test in control group the right and left leg at the significance level 0.05% at 9 degrees of freedom.

Graph: 1 Triple hop distance test Control group:

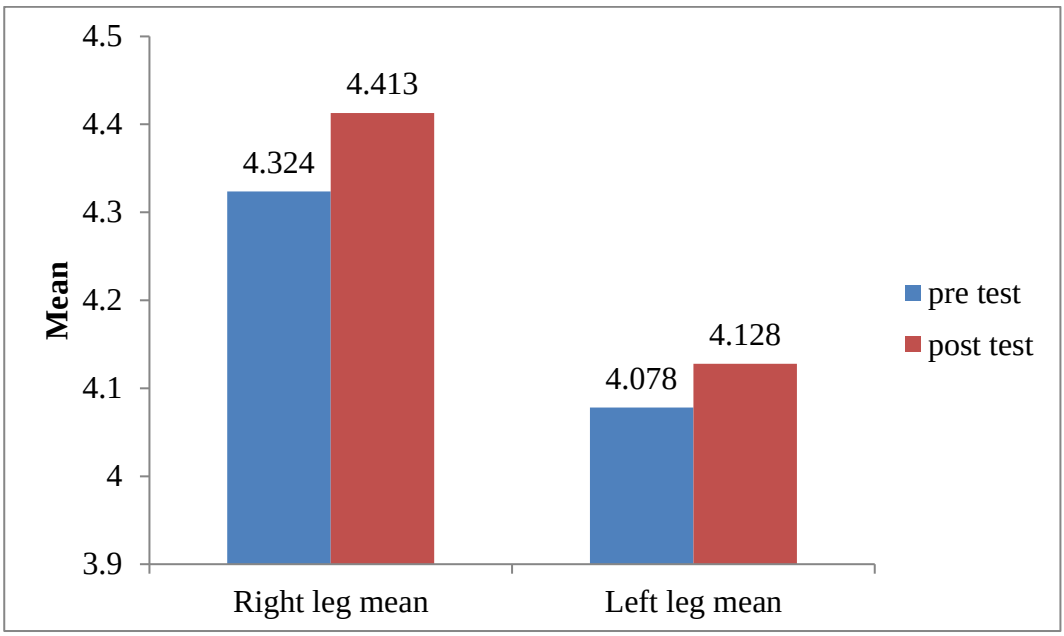


Table: 2 Triple hop distance test Experimental group :

Outcome measure	Test	Mean	Standard deviation	Calculates 't' value	P value
THDT (RT)	PRE TEST	4.3460	0.4402	14.0444	0.0001
	POST TEST	4.8750	0.3431		
THDT (LT)	PRE TEST	4.1200	0.3787	16.7629	0.0001
	POST TEST	4.5240	0.3990		

There was a significant difference in the outcome measure of Triple hop distance test in Experimental group the right and left leg at the significance level 0.05% at 9 degrees of freedom.

Graph : 2 Triple hop distance test Experimental group :

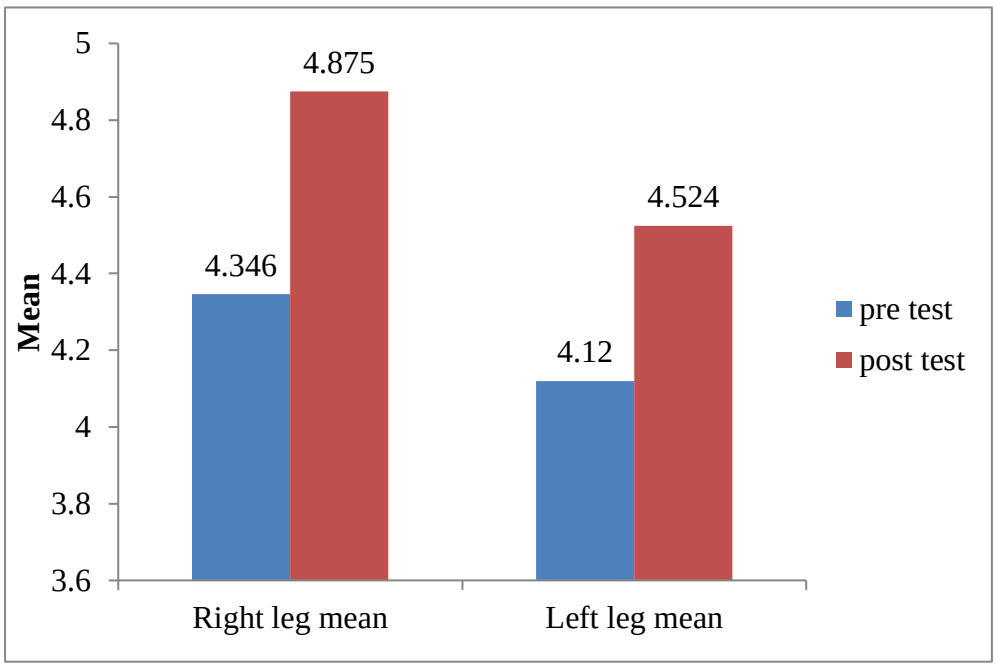


Table: 3Triple hop distance test control group and experimental group

Outcome measure	Test	Mean	Standard deviation	Calculates 't' value	P value
THDT (RT)	Control group Post test	4.4130	0.4303	2.6550	0.0161
	Experimental group Post test	4.8750	0.3431		
THDT (LT)	Control group Post test	4.1280	0.3490	2.2310	0.0387
	Experimental group Post test	4.5240	0.3990		

There was a significant difference in the outcome measure of Triple hop distance test Control group and Experimental group the right leg at the significance level 0.05% at 18 degrees of freedom. Triple hop distance test Control group and Experimental group the left leg at the significance level 0.05% at 18 degrees of freedom.

Graph: 3 Triple hop distance test control group and experimental group

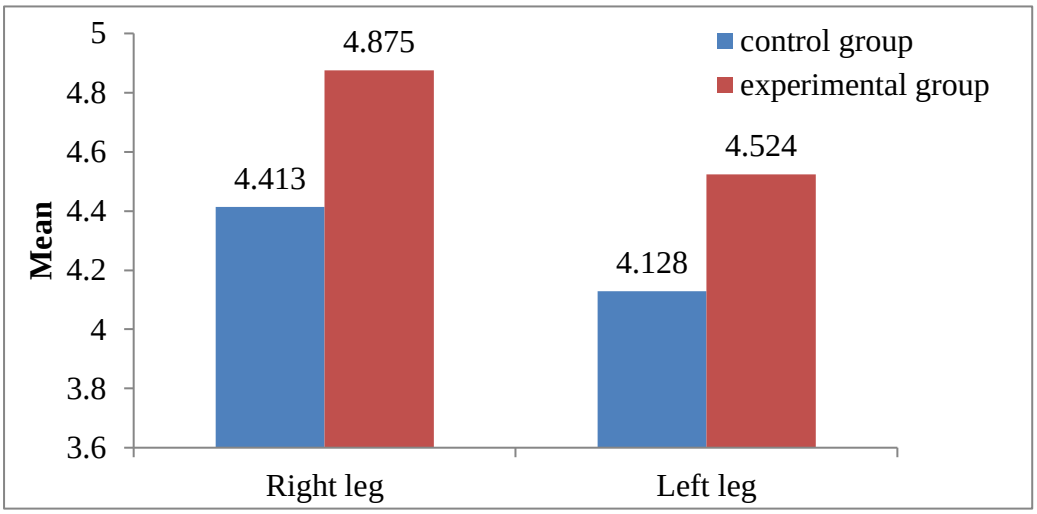


Table: 4 Repeated sprint ability test Control group

Outcome measure	Test	Mean	Standard deviation	Calculates 't' value	P value
RSAT	Pre test	15.8660	1.0229	7.5726	0.0001
	Post test	15.7440	1.0166		

There was a significant difference in the outcome measure of repeated sprint ability test Control group at the significance level 0.05% at 9 degrees of freedom.

Graph: 4 Repeated sprint ability test Control group

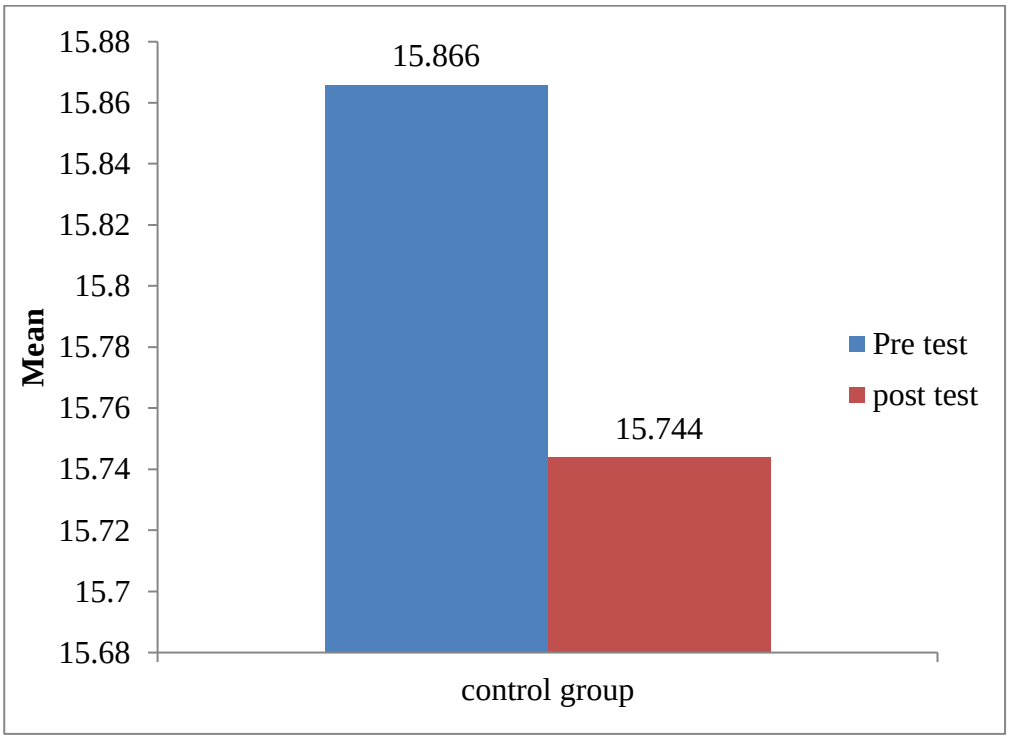


Table: 5 Repeated sprint ability test Experimental group

Outcome measure	Test	Mean	Standard deviation	Calculates 't' value	P value
RSAT	Pre test	15.6100	0.6866	6.6477	0.0001
	Post test	14.9590	0.4381		

There was a significant difference in the outcome measure of repeated sprint test Experimental group at the significance level 0.05% at 9 degrees of freedom.

Graph : 5 Repeated sprint ability test Experimental group

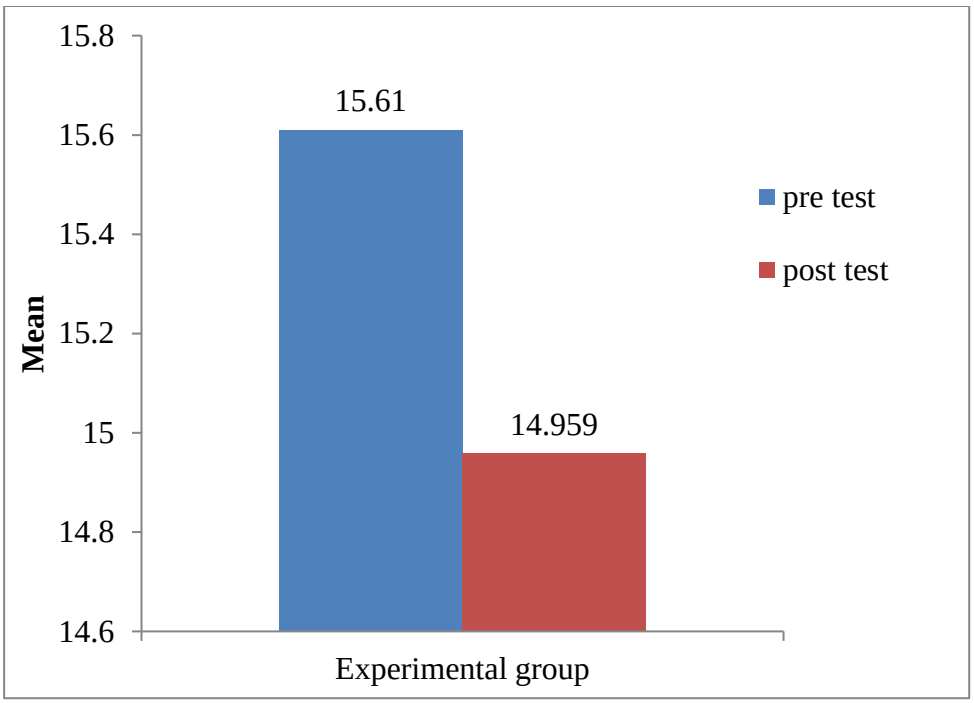
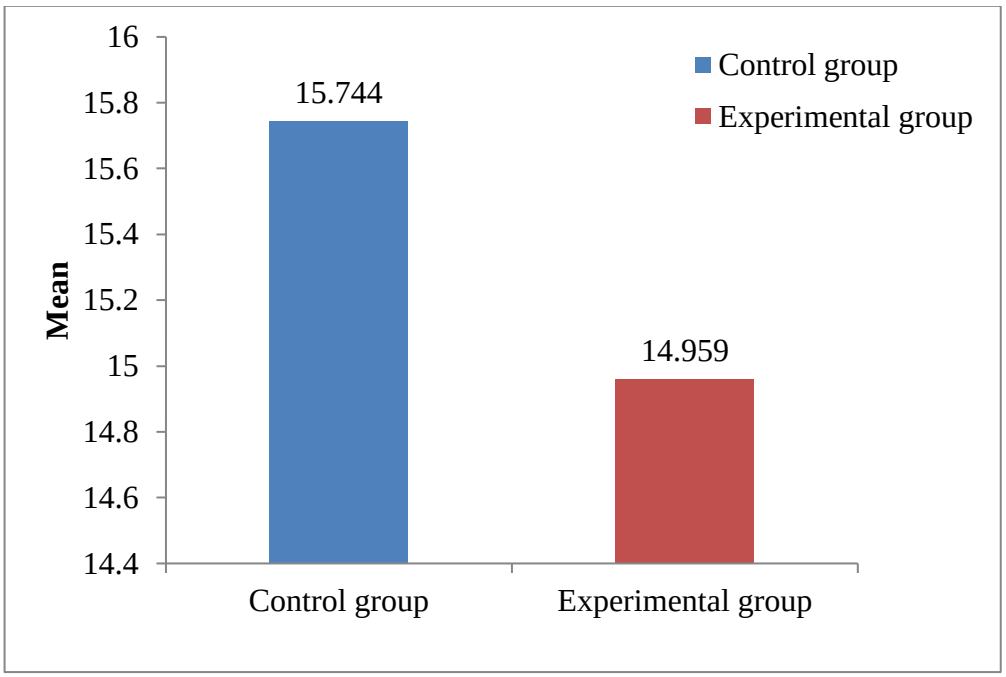


Table: 6 Repeated sprint ability test Control group and Experimental group

Outcome measure	Test	Mean	Standard deviation	Calculates 't' value	P value
RSAT	Control group Post test	15.7440	1.0166	2.2426	0.0378
	Experimental group Post test	14.9590	0.4381		

There was a significant difference in the outcome measure in Repeated sprint ability test Control group and Experimental group at the significance level 0.05% at 18 degrees of freedom.

Graph : 6 Repeated sprint ability test Control group and Experimental group



5. DISCUSSION

The purpose of the study has to been investigated that the effect of warm-up training and along with hamstring eccentric exercises program and versus warm-up training alone, to evaluate a sprinting speed performance and muscular strength in semi-professional football players. That we hypothesized the players whoare all participated in the Experimental group warm-up training along with Nordic hamstring exercises training program would experience an improved in sprinting speed performance and improved muscular strength are compared to the control group who participated in a general warm-up training program only.

The Result was concluded that, there is improvement in between the both groups the sprinting speed performance and muscular strength among both the groups but Experimental group is highly significantly improved by comparing with control group. within the group comparison of pre and post test data of triple hop distance test among the Experimental group has showed a highly significantly difference by using paired “t” test for the right leg mean difference 0.529 with level of significance <0.05% at 9 degree of freedom. Left leg mean difference 0.404 with level of significances <0.05% at 9 degree of freedom. In Experimental group. Repeated sprint ability test showed a highly significantly difference in paired “t” test mean difference 0.651 with level of significances <0.05% at 9 degree of freedom.

Comparison of pre and post test data for triple hop distance test among control group showed significant difference in the paired "t" test for right leg mean difference 0.089 with level of significances <0.05% at 9 degree of freedom. Left leg mean difference 0.05 with level of significances <0.05% at 9 degree of freedom. In control group the repeated sprint ability test showed significant difference in paired "t" test mean difference 0.122 with level of significances <0.05% at 9 degree of freedom.

While considering the comparison between post mean of triple hop distance test among control group and experimental group. The experimental group has been showed high significant difference in the independent "t" test for right leg mean difference 0.462 with level of significances <0.05% at 18 degree of freedom. The comparison of post mean difference on Left leg mean difference 0.396 with level significance <0.05% at 18 degree of freedom, repeated sprint ability test comparison between the post mean of control group and experimental group the experimental group has been showed highly significant difference in the independent "t" test with mean difference of 0.785 with level of significances <0.05% at 18 degree of freedom.

Another point is that, Nordic hamstring exercises can be considered as a closed chain exercise according to the conditions of closed chain motion described by Steindler. There is proposition that closed chain exercise provide greater proprioception and kinesthesia because axial loading provides joint approximation which is believed to stimulate mechanoreceptors in muscles and joint[31]. These factors

might have a positive effect on the muscular strength and sprinting speed. The warm up will have benefits on the speed and strength of muscular contraction due to the increase in temperature of the muscles.

This might be the reason for improving the parameters in both groups. But significant improvement is observed in Experimental group. It can be explained by the concept of lever system. During prone leg hangs, the lever is the lower leg, fulcrum is knee joint, effort is supplied by contraction of Hamstring muscle at its insertion and weight is the weight of the lower leg and pull force of gravity or weight of the resistance added. This can be considered as a third order lever. During this eccentric contraction only small amount of muscular contraction is required to achieve a much more rapid and extensive movement compared to NHE. While performing NHE, hip joint is stabilized by muscular contraction to form a lever. The fulcrum is knee joint; weight of the body is transmitted to tibia. The effort is applied at the origin of Hamstring muscles[32].These factors would have contributed to the significant change in Experimental group compared to control group.

6. CONCLUSION

The results of the study showed that Nordic Hamstring Exercise demonstrated a significant improvement in sprinting speed, muscular strength, as measured by triple ho distance test, repeated sprint ability test 30-m respectively after 5 weeks of training. Thus it can be concluded that, Nordic Hamstring Exercise is effective in improving sprinting speed, muscular strength, and semi-professional football players. Since, improvement in physical fitness parameters like sprinting speed, muscular strengthcan prevent easy fatigue of the muscles thereby enhancing the efficiency of activities of daily living, it can be concluded that Nordic Hamstring exercise is an effective training program that can be incorporated in routine exercise program. Nordic Hamstring Exercise is easy to perform, is not a big time consumer, and can be done without the use of any additional equipment.

6.1 LIMITATION

- The study is conducted for only 5 weeks.
- Small sample size 20 subjects were taken into the study.
- Only the male subject included in the study.
- There is a lack of follow up.

6.2 RECOMMENDATIONS

- Further studies including large sample sizes and study duration should be extent.
- More research is needed to further explore the real benefit of sprinting capacity.
- The female subjects can be included.
- Hamstring injuries are commonly seen in sports activities. So professional player can be taken as a sample for the study.
- Follow up need to assess the long term improvement in effect of treatment.
- Future studies could examine the relation between core muscle strength and NHE and its effect on hamstring injury as well as performance.

REFERENCES

1. Arnason A, Andersen TE, Holme I, Engebretsen L, Bahr R. Prevention of Hamstring strains in elite soccer: an intervention study. *Scand J Med SciSports*. 2008; 18:40-48.

2. Brooks J, Fuller CW, Kemp S, Reddin DB. Incidence, risk, and prevention of Hamstring muscle injuries in professional rugby union. *Am J Sports Med*.2006; 34:1297-1306.

3. Ekstrand J, Gillquist J. Soccer injuries and their mechanisms: a prospective study. Med Sci Sports Exercise1983; 15:267–70.

4. Garrett WE Jr. Muscle strain injuries. Am J Sports Med 1996;24(6Supply):S2–8.

5. Woods C, Hawkins RD, Maltby S, et al. The football association medical research programmed: an audit of injuries in professional football: analysis of hamstring injuries. Br J Sports Med 2004; 38:36–41

6. Verrall GM, Slavotinek JP, Barnes PG, et al. Clinical risk factors for hamstring muscle strain injury: a prospective study with correlation of injury by magnetic resonance imaging. Br J Sports Med 2001; 35:435–9.

7. Connell Da, Schneider-Kolsky ME, Hoving JL, et al. Longitudinal study comparing sonographic and MRI assessments of acute and healing hamstring injuries. AJR Am J Roentgenol2004;183:975–84.

8. Verrall GM, Slavotinek JP, Barnes PG, et al. Clinical risk factors for hamstring muscle strain injury: a prospective study with correlation of injury by magnetic resonance imaging. Br J Sports Med 2001; 35:435–9.

9. Connell Da, Schneider-Kolsky ME, Hoving JL, et al. Longitudinal study comparing sonographic and MRI assessments of acute and healing hamstring injuries. AJR Am J Roentgenol 2004; 183:975–84.

10. Askling CM, Tengvar M, Saartok T, Thorstensson A. Acute first-time hamstring strains during slow-speed stretching: clinical, magnetic resonance imaging, and recovery characteristics. The American journal of sports medicine. 2007; 35(10):1716–1724. [PubMed: 17567821]

11. Askling CM, Tengvar M, Saartok T, Thorstensson A. Proximal hamstring strains of stretching type in different sports: injury situations, clinical and magnetic resonance imaging characteristics, and return to sport. The American journal of sports medicine. 2008; 36(9):1799–1804. [PubMed: 18448581]

12. Brukner, P.; Khan, K.; Brukner, P. 4th. Sydney ; New York: McGraw-Hill; 2012. Brukner& Khan's clinical sports medicine;1296

13. Cacchio A, Borra F, Severini G, Foglia A, Musarra F, Taddio N, et al. Reliability and validity of three pain provocation tests used for the diagnosis of chronic proximal hamstring tendinopathy. British journal of sports medicine. 2012; 46(12):883–887. [PubMed: 22219215]

14. De Vos RJ, Reurink G, Goudswaard GJ, Moen MH, Weir A, Tol JL. Clinical findings just after return to play predict hamstring re-injury, but baseline MRI findings do not. British journal of sports medicine. 2014; 48(18):1377–1384. [PubMed: 25037201]

15. Clark R, Bryant A, Culgan JP, HartleyB. The effects of eccentric hamstring strength training on dynamic jumping performance and isokinetic strength parameters: a pilot study on the implications for the prevention of hamstring injuries. *Phys Ther Sport*. 2005;6:67-73.

16. Small K, McNaughton L, Greig M, Lovell R. Effect of timing of eccentric hamstring strengthening exercises during soccer training: implications for muscle fatigability. *J Strength Cond Res*. 2009;23:1077-1083.

17. Gabbe BL, Branson R, Bennel KL. A pilot randomized controlled trial of eccentric exercise to prevent hamstring injuries in community-level Australian football. *J Sci Med Sport* 2006; 9: 103-09.

18. Petersen J, Thorborg K, Bachmann M, et al. Preventive Effect of Eccentric Training on Acute Hamstring Injuries in Men's Soccer: A cluster-Randomized Controlled Trial. *Am J Sports Med* 2011;39: 2296-2303.

19. De Weijer VC, Gorniak GC, Shamus E. The effect of static stretch and warm-up exercise on hamstring length over the course of 24 hours. *J Orthop Sports Phys Ther* 2003;33: 727–33.

20. Potier TG, Alexander CM, Seynnes OR. Effects of eccentric strength training on biceps femoris muscle architecture and knee joint range of movement. *Euro J ApplPhysiol*2009;105:939–44.

21. Reeves ND, Maganaris CN, Longo S, *et al*. Differential adaptations to eccentric versus conventional resistance training in older humans. *Exp Physiol*2009;94:825–33.

22. J. Augustsson, R. Thomeé, C. Lindén, M. Folkesson, R. Tranberg,
J. Karlsson, Single-leg hop testing following fatiguing exercise: Reliability and biomechanical analysis, Scand. J. Med. Sci. Sport. 16 (2006) 111–120. doi:10.1111/j.1600-0838.2005.00446.x.

23. R.T. Hamilton, S.J. Shultz, R.J. Schmitz, D.H. Perrin, Triple-hop distance as a valid predictor of lower limb strength and power, J. Athl. Train. 43 (2008) 144– 151. doi:10.4085/1062-6050-43.2.144.

24. A.S. Bley, J.C.F. Correa, A.C. Dos Reis, N.D.D.A. Rabelo, P.H. Marchetti, P.R.G. Lucareli, Propulsion Phase of the single leg triple hop test in women with patellofemoral pain syndrome: A biomechanical study, PLoS One. 9 (2014)e97606. doi:10.1371/journal.pone.0097606.

25. M.G. Pandy, F.E. Zajac, Optimal muscular coordination strategies for jumping, J.Biomech. 24 (1991) 1–10. doi:10.1016/0021-9290(91)90321-D.

26. Baker J, Ramsbottom R, Hazeldine R (1993) Maximal shuttle runningover40masameasureofanaerobicperformance.BrJ Sport Med 27,,228−232

27. Nagahama H, Isokawa M, Suzuki S, Ohashi J (1993) Physical fitness of soccer players a Reacted by a maximal intermittent exercise ‘‘MIE’’. In,, Reilly T, Clarys J, Stibbe A (eds) Science and football. II. Spon, London, pp 46−52

28. Nummela A, AlbertsM, RjintjesRP, Luhtanen P, Rusko(1996) Reliability and validity of the Maximal Anaerobic Running Test. Int J Sports Med 17,,S97−S102

29. Reilly T (1996) Energetic of high-intensity exercise (soccer) with particular reference to fatigue. J Sports Sci 15,, 257−263

30. Reilly T, Thomas V (1976) A motion analysis of work-rate in deferent positional roles in professional football match-play.J Hum Mov Stud 287−89

31. Kinesiology of human body under normal and pathological conditions. Arthur Steindler, Charles C Thomas Publishers. USA.5th edition.

32. The principles of Exercise Therapy. M Deena Gardiner. CBS Publishers & Distributors, Delhi. 2005, 4th Edition. Chapter 2: 110-13.

BIBLIOGRAPHY

1. Rehabilitation Research: principle and application by Elizabeth Domholdt (Elsevier health science IV, 2004)
2. Kinesiology of human body under normal and pathological conditions. Arthur Steindler, Charles C Thomas Publishers. USA.5th edition.
3. The principles of Exercise Therapy. M Deena Gardiner. CBS Publishers & Distributors, Delhi. 2005, 4th Edition. Chapter 2: 110-13
4. Exercise physiology by Mc Ardle, Katch and Katch (Lippincott Williams and Wilkins, 2000)
5. Sports physiotherapy by Maria Zuluga, Christopher Briggs and John Carlisle.
6. Clinical sports medicine by Peter Brukner and Karim Khan third edition 2008
7. Joint structure and function: a comprehensive analysis by Cynthia C Norkin, Pamela K Levangi (Jaypee Brothers, 2006)
8. Orthopedic sports medicine, mark D. Miller, 3rd edition: 2009, Saunders Elsevier
9. Sports injuries prevention and their treatment by lass Peterson 1st edition (martin Donitz, 2001)
10. Therapeutic exercise: foundation and techniques by Carolyn Kisner and Lynn Allen Colby (W.B Saunders Company, 2007)
11. Basic biomechanics of the musculoskeletal system by Margareta Nordin and victor H. Frankle,2nd edition (Lea and Fibiger)

APPENDICES

APPENDIX I

ASSESSMENT

Name:

Age:

Date:

Gender:

Address:

Occupation:

Weight: Height: Dominant: BMI:

Personal medical history

Diabetes	Yes/no
Kidney disease	Yes/no
Blood pressure	Yes/no
Thyroid disease	Yes/no
Asthma	Yes/no
Cardiac disease	Yes/no
Respiratory problem	Yes/no
Digestive disorders	Yes/no
Musculoskeletal Disorders	Yes/no
Injury lower extremities injury/upper extremities injury / back pain/hamstring injury	Yes/no

Surgical history

Abdominal surgery	Yes/no
Spine surgery	Yes/no
Any other implants / Fracture	Yes/no

Personal history

Cigarette smoking	Yes/no
Drinking alcohol	Yes/no
Bowel and bladder dysfunction	Yes/no
Under any medications	Yes/no
Any supplements	Yes/no
Habit of regular exercise	Yes/no

Vital sign

Heart rate:

Blood Pressure:

Respiratory rate:

Temperature:

Spo2:

Physical variables

TEST	**PRE TEST**		**POST TEST**	
THDT	Right(cm)	Left(cm)	Right(cm)	Left(cm)
RSAT (30-m)				

APPENDIX II

General warm-up training:

Consisting of jogging progressing to light sprinting was performed for 10 min.

Butt kicks:

- Stand with your legs shoulder-width apart. Your arms should be bent your sides.
- Flex the right knee and kick your right heel up toward your glutes. Bring the right foot back down.
- As the right leg comes down, flex your left knee and kicks your foot up toward your glutes. Swing your arms as if you were jogging.
- Repeated in 3 sets of 20 repetition

(**Figure: 1) BUTT KCKS**

Knee to chest:

- Stand with your feet shoulder -width apart. Maintain a tight core throughout. Lift your left knee up and towards your chest.
- Grab your left knee and pull it in as close as you can into chest. Hold this stretch.
- Slowly release the left leg to the ground and repeated on the other side 3 sets of 10 repetition.

(Figure: 2) KNEE TO CHEST

Self-stretch:

- Use support from a partner or stationary object such as a chair or low table.
- The knee should be bent at the start, and the ankle relaxed.
- Press the heel against the ground for 5-10 seconds to activate the hamstring muscles.
- Then relax and use your hand to extend your knee. Hold the stretch for about 20 seconds.
- If necessary, increase the distance between your legs and bend your hips little more,
- But keep your back straight. Stretch each thigh three times.

(Figure: 3) Self stretch

Partner stretch:

- Your partner raises your leg with the knee bent, until you feelthe back of the thigh stretch.
- Hold this position for a few seconds before you press your leg towards your partners shoulder.
- Hold for 10 seconds. Then relax while your partner stretches firmly, but cautiously by leaning forward.
- Hold this position for 45 seconds. Stretch each thigh three times.

(Figure: 4) partner stretch

Nordic hamstring lowers:

- Your partner holds your legs stable. Lean slowly forward with a steady speed.
- Hold your back and hips straight.
- Try to resist with your hamstring muscles as long as possible, until you lose your balance and fall on your arms.
- As you get stronger, make the exercise more demanding by increasing speed in the beginning of the movement, even by being "pushed" by your partner. Let the chest touch the ground.
- Use your arms to push up immediately, until your hamstring muscles can take over the movement and pull you up to the starting position.
- Be careful in the beginning, use two sets with 5 reps, and increase slowly to 3 sets with 12 reps

Beginning position

Mid position

(Figure: 5) Ending position for Nordic hamstring lowers.

Triple hop distance test:

- Stand with single leg, perpendicular to starting line.
- Participants stood on the designated testing leg, with the great toe on the starting line
- They performed 3 consecutive maximal hops forward on the same limb.
- Arm swing is not allowed placed behind back.
- The investigator measured the distance hopped from the starting line to the point where the heel struck the ground upon completing the third hop.
- All participants were allowed 1 to 3 trials on each leg and then completed 3 test trials.
- The distance is measured with standard tape in centimeters.
- Is a method of measuring the muscular strength of lowers to assess functional performance. THD is strong predictor of lower limb muscular strength in healthy semi- professional football players.

(Figure: 6) Triple hop distance test

Repeated sprint ability test:

- Marker cones and lines are placed 30 meters apart to indicate the sprint distance.
- Two more cones are placed a further 10 meters along on each end. At the instructions of the timer the subject places their foot at starting line.
- Then on ‘go’ to stopwatches are started and the subject sprints maximally for 30m, ensuring that they do not slow down before reaching the finish line.
- Those assessments allow adequate prescription and monitor improvements caused by physical training aiming high-performance attainment.
- Is a method of measuring the sprinting capacity to assess functional performance in healthy semi- professional football players.

(Figure: 7) Repeated sprint ability test

APPENDIX III

INFORMED CONSENT FORM

I _____ agree to take part in the study, conducted by _____' post graduate student (MPT), Sri Ramakrishna Institute of Paramedical sciences, college of physiotherapy, Dr.MGR University.

I acknowledge that the research study has been explained to me and I understand that agreed to participate in the research.

- Provide information about my health status to the researcher.
- Allow the researcher to have access my medical records for purpose of the study.
- Participate in the analysis program.
- Make myself available for further analysis if required.

I have been informed about the purpose, procedures and measurements involved in the research and my queries towards the research have been clarified.

I understand that my participation is voluntary and can withdraw at any stage of the research.

Signature of the participant:

Contact Address:

Signature of investigator:Date: